LANDSAT DATA CONTINUITY MISSION

STATEMENT OF WORK
FOR THE
OPERATIONAL LAND IMAGER

DRAFT

June 10, 2004

Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

CM FOREWORD

This document is an LDCM Configuration Management (CM)-controlled document. Changes to this document require prior approval of the LDCM Program Manager. Proposed changes shall be submitted to the LDCM Configuration Management Office (CMO), along with supportive material justifying the proposed change. Changes to this document will be made by complete revision.

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LDCM PROJECT

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List of TBDs/TBRs

Item No.	Location	Summary	Ind./Org.	Due Date

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1.0 <u>INTRODUCTION</u>

1.1 GENERAL

This Statement of Work (SOW) defines the minimum effort required by the Contractor for the design, analysis, development, fabrication, integration, test, evaluation and support for the Landsat Data Continuity Mission (LDCM) Operational Land Imager, hereafter referred to as OLI. This Statement of Work requires delivery of two OLI instruments plus the option for a third instrument. All instruments shall be designed for accommodation on the National Polar-orbiting Operational Environmental Spacecraft System (NPOESS) spacecraft. The OLI shall be designed such that it meets the interface requirements of the NPOESS 2130 spacecraft as detailed in the current revision of the NPOESS General Instrument Interface Document, as modified by accepted exceptions documented in the Spacecraft-to-Instrument Interface Control Document.

1.2 SCOPE

In accordance with the requirements of the OLI Specification and the other attachments to this contract, the Contractor shall provide the personnel, materials, equipment, and facilities necessary for the design, analysis, development, fabrication, assembly, test, engineering data analyses, calibration, qualification, delivery, and support of the OLI. The OLI consists of the Reflective Band Sensor and the Data Storage and Playback (DSAP) Subsystem. The OLI shall be designed for a seven-year post-launch lifetime.

The contractor shall deliver to the spacecraft provider an OLI that is fully tested, calibrated, and has demonstrated reliable operation in accordance with the MAR. The contractor shall deliver an OLI that is ready for integration with the spacecraft and ready to support spacecraft level testing.

Following OLI delivery the Contractor shall support post-delivery testing, spacecraft integration, spacecraft test, and preparation of the integrated spacecraft for shipment to the launch facility. At the launch facility the contractor shall provide pre-launch support. The Contractor shall provide post-launch support for OLI checkout, verification of on-orbit performance, and anomaly resolution. In support of the above activities, the Contractor shall provide the required reports, reviews and documentation identified in the contract.

The Contractor shall provide the personnel, materials, facilities and other resources to design, develop, deliver and support under the basic contract: two Flight Model OLIs (FM-1 and FM-2), one Engineering Model OLI, one Structural Thermal Model OLI, one Instrument Electrical Emulator, all spares for the above, all GSE, and all items and documents specified in the Applicable Documents and the CDRL.

If the option is exercised, the Contractor shall provide the personnel, materials, facilities and other resources to design, develop, deliver and support Option 1 for an additional Flight Model (FM-3).

2.0   REQUIREMENTS PRECEDENCE

The order of requirements precedence is this Statement of Work, the OLI Specification, the Special Test Requirements (STR) document, the OLI Mission Assurance Requirements (MAR) document, then referenced and applicable documents.

3.0   MANAGEMENT

3.1   PROJECT MANAGEMENT

The Contractor shall maintain a project office that shall manage the technical activities and resources of the OLI project. The Contractor shall appoint a dedicated Project Manager to direct and manage the OLI project. The Contractor's Project Manager shall have responsibility for the overall technical performance and resource management of the contractual effort and all subcontracts. The Contractor's designated Project Manager shall report to a level of company management appropriate to ensure prompt resolution of all problems. The Contractor shall develop and have available for review a Project Management Plan which addresses the overall organization, management approach, and structure of the OLI Project plus its interrelationships with the parent company and subcontractors, and its relationship with the Government.

The Contractor shall establish and maintain a comprehensive risk management and mitigation program in accordance with the MAR. Risks and mitigation analyses shall include risks to the OLI performance, reliability, and schedule. The Contractor's risk list shall be presented and reviewed at all Monthly Project Status Reviews (MPSRs).

The Contractor shall provide to the Government, for review purposes, electronic access to all completed reports, analyses, internal technical memoranda, CDRLs, and all other documents relating to the development and management of OLI contained in electronic data bases customarily used by the contractor for projects such as OLI. Within the data bases the Contractor shall maintain an index of the material and update this index at least monthly. The material contained in these electronic databases may be in contractor format. The Contractor shall provide Contractor-Generated Internal Technical Information, as requested by the Government, in accordance with the CDRL.

The Contractor shall provide suitable facilities, including office space, furniture, access to a conference room, file/storage area, and telecommunications access, to support one Government in-plant representative and one visiting Government representative.

The Contractor shall prepare a Final Report at the end of the contract period in accordance with the CDRL.

3.2   RESOURCE MANAGEMENT

The Contractor shall implement an Earned Value System (EVS). The EVS may be implemented in accordance with the Contractor's standard plans and policies, provided it conforms to the minimum reporting requirements of NPG 9501.2D, NASA Contractor Financial Management Reporting, including use of NASA Form 533 reports. The Contractor shall provide Financial Reports and Earned Value System Reports to the Government in accordance with the Contract Data Requirements List (CDRL) and the contractor's standard policies and

procedures. The Contractor shall develop and provide an EVS Baseline Review Package in accordance with the CDRL.

The Contractor shall segregate, track, and report individual work efforts in accordance with a Contractor-defined Work Breakdown Structure (WBS). The Contractor shall develop and deliver a WBS Diagram and Task Description Updates in accordance with the CDRL.

3.3   CONFIGURATION MANAGEMENT

The Contractor shall establish and maintain a configuration management system. This system may be in accordance with the contractor's standard plans and policies, provided the configuration management requirements identified in the MAR document are satisfied. The Contractor shall have available for Government review a Configuration Management Plan which describes the scope, approach, methods, and procedures used to control changes of requirements and design. The Contractor shall submit for approval Configuration Change Requests for Class I changes in accordance with the CDRL.

3.4   REVIEWS AND MEETINGS

3.4.1   MONTHLY PROJECT STATUS REPORTS

The Contractor shall communicate the status of the technical effort, program schedule, and financial condition to the LDCM Project on a regularly scheduled basis. The Contractor shall conduct Monthly Project Status Reviews (MPSRs), including presentation package, in accordance with the CDRL. The MPSR shall include Detailed Schedules in accordance with the CDRL. The MPSR shall be conducted face-to-face unless otherwise agreed in advance.

3.4.2   TECHNICAL INTERCHANGE MEETINGS

The Contractor shall conduct informal Technical Interchange Meetings (TIMs) with the Government on technical issues arising during the program, specifically concerning performance or reliability issues. Either the Contractor or the Government may request a TIM. The Contractor shall track action items arising from TIMs for resolution/response and report status at the MPSRs.

The Contractor shall conduct Technical Interchange Meetings with subcontractors for issues concerning critical assemblies and subassemblies and provide the Government 10 days advanced notice so that the Government can attend.

3.4.3   PEER REVIEWS AND PACKAGING REVIEWS

The Contractor shall conduct a program of peer reviews at the component and subsystem level and during all phases of the project life cycle. The Contractor shall conduct packaging reviews on all electrical and electromechanical components in the flight system including electrical interconnection harness design and assembly requirements.

At the peer reviews, the Contractor shall evaluate the ability of the component or subsystem to successfully perform its function under operating and environmental conditions during both testing and flight. The Contractor shall present the results of analyses, including the results of associated tests.

The packaging reviews shall specifically address the following: Placement, mounting, and interconnection of EEE parts on circuit boards or substrates, structural support and thermal accommodation of the boards and substrates and their interconnections in the component design, and provisions for protection of the parts and ease of inspection.

The Contractor shall conduct hardware design peer reviews with personnel who are not directly responsible for design of the hardware under review. To promote continuity of the whole review program and allow for participation of the GSFC LDCM Project and System Review Office, the Contractor shall provide the peer review schedule to the GSFC LDCM Project. The Contractor shall document the results of the reviews in Peer Review Data Packages in accordance with the CDRL.

3.4.4   DAILY TEST STATUS AND PLANNING MEETINGS

The Contractor shall allow the Government access to Contractor daily test status and planning meetings.

3.4.5   MAJOR PROGRESS REVIEWS

In addition to MPSRs, TIMs, and peer reviews, the Contractor shall prepare and conduct the following (external independent) major progress reviews and provide review packages in accordance with the CDRL:

Instrument System Requirements Review (ISRR)
Instrument Preliminary Design Review (IPDR)
Instrument Critical Design Review (ICDR)
Instrument Pre-Environmental Review (IPER)
Instrument Pre-Ship Review (IPSR)

The Contractor shall prepare and conduct design reviews (PDR and CDR) and Pre-Ship Reviews for all subsystems, including, but not limited to, the focal plane assembly, telescope, and DSAP.

These reviews should not be considered a comprehensive set of reviews for the Contractor's program. Additional reviews that the Contractor deems necessary to successfully execute the program should be conducted at the Contractor's discretion. In general, the Contractor shall notify the Government at least 10 working days in advance of lower level Contractor subsystem reviews to allow the Government time to attend the review as part of its insight activities.

3.4.6   SUPPORT TO MISSION LEVEL REVIEWS

The Contractor shall prepare Data in Support of Mission Level Reviews in accordance with the CDRL. The Contractor shall participate in Mission Level Reviews as requested by the Government, and respond to action items from Mission Level reviews. These Mission Level Reviews are the System Requirements Review (SRR), Preliminary Design Review (PDR), Critical Design Review (CDR), Pre-Environmental Review (PER), Mission Operation Review (MOR), Pre-Ship Review (PSR), Flight Operation Review (FOR), Mission Readiness Review (MRR), the Launch Readiness Review (LRR), the Launch Readiness Review (LRR) and the Initial Operational Capability Review (IOCR).

The Contractor shall prepare status and summary charts, participate in, and respond to action items from a post-launch review of spacecraft and instrument performance.

3.4.7   RESPONSES TO FORMAL ACTIONS

The Contractor shall develop and apply a process for capturing and responding to review action items identified by the Government. The Contractor shall provide Responses to Formal Actions (RFAs) in accordance with the CDRL. Major progress reviews, as defined above, are not complete until actions are dispositioned, subject to the approval of the Contracting Officer.

4.0   SYSTEM ENGINEERING

The Contractor shall perform systems engineering tasks necessary to assure that all requirements of this contract are accomplished successfully and on time. Systems engineering generally consists of requirements definition, allocation, and traceability, requirements change control and documentation, and verifying conformance of the system to the requirements. Systems engineering also consists of definition and control of internal and external interfaces.

4.1   OLI SYSTEMS ENGINEERING

The Contractor shall perform all required OLI systems engineering tasks to assure that all requirements of this contract are accomplished successfully and on time. These systems engineering tasks shall include, but are not limited to, the following:

a.   Definition, allocation, and traceability of system and subsystem requirements and verification approach.

b.   Develop and deliver Approved or Controlled Drawings, and Wiring Diagrams in accordance with the CDRL.

c.   Test and calibration requirements definition, including planning for demonstration of compliance with the OLI Specification, the STR, and the MAR.

d.   Develop and deliver the Calibration Validation Plan in accordance with the CDRL.

e.   Conduct test evaluation and test reporting.

f.   Perform OLI performance trending, analyze trend data, and provide Trending Reports in accordance with the CDRL. The Contractor shall perform trending within the normal test framework; i.e., during functional tests, environmental tests, etc. The Contractor shall establish a system for recording and analyzing the trending parameters as well as any changes from the nominal even if the levels are within specified limits.

g.   Develop and deliver the Contamination Control Plan in accordance with the CDRL.

h.   Support OLI system design activities, including design, generation, and testing of mathematical and hardware models necessary to verify that the design meets the requirements of the specification, or to facilitate the integration of the OLI with the spacecraft.

i.   Prepare and conduct table-top reviews of instrument test results with the Government, scheduled as deemed appropriate by the Contracting Officer's Technical Representative (COTR).

j.   Support reviews as required, including response to action items

k.   Manage internal OLI interfaces

l.   Define and control the instrument to spacecraft interfaces until a spacecraft to instrument ICD is completed by the spacecraft vendor. The Contractor shall develop and maintain Interface Control Documents Inputs in accordance with the CDRL.

m.   Interface and coordinate with the spacecraft contractor(s) in development, design and test of spacecraft interfaces, including attendance at meetings at the spacecraft contractor's facility.

n.   Maintain and control critical OLI margins, including mass, power, and performance.

o.   Provide the Orbital Debris Assessment Inputs in accordance with the CDRL.

p.   Provide an OLI Data Users Manual in accordance with the CDRL.
q.   Provide the Operation and Maintenance Manuals in accordance with the CDRL.

4.2   SYSTEMS ANALYSIS

The Contractor shall, in coordination with systems engineering activities, perform the necessary analyses to assure that all requirements of this contract are accomplished successfully and on time. These systems engineering analyses shall include, but are not limited to, the following; visible and infrared Reflective Band Sensor (RBS) radiometry, spatial, spectral, optics, polarization, stray light (including stray light from spacecraft and reflected off solar diffuser), electronics, structure, thermal system, contamination, optical/electrical/radiometric sensitivity to temperature changes, line of sight jitter, and DSAP throughput analyses. All analyses performed by the contractor under this contract shall be provided in accordance with the Engineering Analyses and Test Reports CDRL.

4.3   SPECIAL STUDIES, ANALYSES, AND TASKS

The Contractor shall prepare, in addition to the requirements specified in this document and the contract, additional engineering studies, technical analyses, design modifications, and tasks as requested by the COTR. In advance of initiation of any work associated with these activities, the contractor shall propose to the COTR the specific task elements which will be performed, and the labor and materials costs associated with the effort. For planning purposes, the Contractor should anticipate that most of the studies and tasks will be performed prior to ICDR. In addition, the Contractor may propose Engineering Analyses and Tests. Results of special studies, analyses, and tests, whether Government or Contractor proposed, shall be reported in Engineering Analysis and Test Reports in accordance with the CDRL.

5.0   <u>**FLIGHT MODEL 1 (FM-1) DESIGN AND DEVELOPMENT**</u>

5.1   **DESIGN ENGINEERING**

The Contractor shall provide all personnel, equipment and facilities necessary for the design and development effort of the OLI. This effort shall include the electrical, structural, mechanical, thermal, data, and safety and reliability design of the OLI, the OLI to spacecraft interface design, command and data formats, the RBS calibration, and ground support equipment. The OLI shall include the Reflective Band Sensor (RBS) and the Data Storage and Playback (DSAP) Subsystem. The RBS shall contain the optical subsystem, the calibration subsystem, focal plane and focal plane electronics, and the optical bench. The DSAP shall include the data storage subsystem and the data handling and formatting subsystem.

5.1.1 ALGORITHMS AND MATHEMATICAL MODELS

The Contractor shall develop and provide OLI algorithms and models as defined below:

5.1.1.1 Algorithms and Calibration Parameters

The Contractor shall develop and deliver Algorithms and Calibration Parameters in accordance with the CDRL.

5.1.1.2 Radiometric Math Model

The Contractor shall develop and maintain a Radiometric Math Model in accordance with the CDRL.

5.1.1.3 Thermal Math Model

The Contractor shall develop and maintain a Thermal Math Model in accordance with the CDRL.

5.1.1.4 Structural Math Model

The Contractor shall develop and maintain an OLI Structural Math Model in accordance with the CDRL. The Contractor shall verify the accuracy of the model by dynamic test data. The Contractor shall update the model to agree with the structural test results.

5.1.1.5 OLI Optical Analytical Model

The Contractor shall develop and maintain an OLI Optical Analytical Model in accordance with the CDRL.

5.1.2 HARDWARE MODELS

5.1.2.1 Structural Thermal Model

The Contractor shall develop a Structural Thermal Model (STM) of the OLI RBS and DSAP to verify physically the structural, thermal, and mechanical design (including vibration testing) and to provide the initial RBS mass distribution. The STM is structurally and mechanically equivalent to the flight unit, but is not capable of the optical or electrical functions of the flight unit. The structure shall be made of flight materials and have a mass and mass distribution like that of a flight unit. The Contractor shall use the STM to verify structural integrity and structural and thermal math models and to verify structural interface with the spacecraft bus.

5.1.2.2 RBS Engineering Model

The RBS Engineering Model (EM) shall be developed in two stages. The first stage is the development of RBS assembly-level EMs. The assembly-level EMs shall be used to evaluate design decisions. Assembly-level EMs are not required to meet instrument performance specifications, but performance shall be capable enough that when the assemblies are integrated, the integrated EM shall be capable enough to meet its intended purpose. The Contractor shall develop an integrated RBS EM to evaluate design decisions and to provide a test bed for anomaly resolution for the flight model instruments. The integration of the EM assemblies may occur at a later stage in the program, but soon enough to be shipped to the spacecraft contractor facility in advance of the flight model. The integrated EM performance is not required to meet instrument performance specifications, but performance (i.e. SNR) shall be capable enough to meet its intended purpose. The EM shall be similar to a flight model in appearance, performance, and interfaces. The EM focal plane assembly shall be fully populated. The EM shall have optics sufficient to produce an image for electrical/data flow evaluation purposes. It shall incorporate parts and components of the same type called for in the flight model design, but they need not be flight-qualified. The Contractor shall also use the EM to verify flight software, verify assembly procedures, test all deployable mechanisms, test the control electronics, and verify interfaces with the spacecraft. The Contractor shall demonstrate the interface of the RBS EM with the DSAP. The RBS EM shall have the same mechanical mounting interfaces to the spacecraft as the flight model RBS. The Contractor shall ship the EM to the spacecraft contractor facility for mechanical and electrical interface checkout. The Contractor shall support the interface checkout and return the EM to the Contractor facility.

The Contractor shall maintain the RBS EM through the life of the mission.

5.1.2.3 DSAP Engineering Model

The Contractor shall develop an EM of the DSAP to verify design decisions, test electrical/data interfaces with the RBS EM and the spacecraft, and to perform anomaly resolution of the flight model DSAP. The DSAP EM shall have representative functional capability of the flight unit. The DSAP EM shall have the same mechanical mounting and electrical interfaces to the spacecraft as the flight model DSAP. The Contractor shall ship the DSAP EM to the spacecraft contractor facility for mechanical and electrical interface checkout. The Contractor shall support the interface checkout and return the EM to the Contractor facility.

The Contractor shall maintain the DSAP EM through the life of the mission.

5.1.3 INSTRUMENT EMULATOR

The Contractor shall design, develop and deliver one instrument emulator to the spacecraft vendor to simulate OLI outputs and electrical interfaces and to interface with the spacecraft emulator.

The Emulator shall simulate all instrument modes and mode transitions. The Emulator shall simulate predefined, scripted anomalies The Emulator shall communicate with a spacecraft emulator for instrument command, telemetry, and science packets. The Emulator shall execute flight code. The Emulator shall accept simulation control commands from either a standalone console or through a TBD interface with the spacecraft emulator. (TBR) The Emulator shall generate housekeeping data reflective of commanded mode. The Emulator shall accept real-time inputs to change simulated telemetry or modeling parameters. The Emulator shall maintain a log of all instrument commands received indicating validity, command mnemonic, and raw bit pattern. The Emulator shall maintain a log of all simulation directives received.

5.2   SUBASSEMBLY, ASSEMBLY, AND UNIT BUILD AND TEST

The Contractor shall provide all personnel, equipment and facilities necessary for the fabrication, assembly, and test of the OLI. The Contractor shall test FM-1 at qualification levels. The Contractor shall plan and perform tests, at the appropriate levels of assembly, which meet the minimum requirements of the MAR and STR. The Contractor shall have available for review by the Government the component and subassembly test reports for all subcontracted items.

5.2.1   REFLECTIVE BAND SENSOR

The Contractor shall provide all necessary engineering and management functions required to fabricate, assemble, and test the OLI RBS.

5.2.2   DATA STORAGE AND PROCESSING SYSTEM

The Contractor shall provide all necessary engineering and management functions required to fabricate, assemble, and test the DSAP.

5.3   OLI SYSTEM INTEGRATION AND TEST

5.3.1   SENSOR/ DSAP SYSTEM INTEGRATION

The Contractor shall integrate the RBS and DSAP. The Contractor shall provide the personnel, facilities, special tools and equipment, and materials necessary to perform the integration.

5.3.2. SYSTEM FUNCTIONAL AND ENVIRONMENTAL TESTING

The Contractor shall verify that the OLI is functional. The Contractor shall verify that the OLI meets performance specifications after exposure to the environments required by the MAR, and as modified by the interface requirements in the NPOESS GIID. The Contractor shall develop a System Performance Verification Plan (SPVP) in accordance with the CDRL. After Contract award, the Contractor shall compare the test environments specified in the MAR with the environmental conditions specified in the NPOESS GIID. The Contractor shall participate in discussions with the Government to resolve these differences prior to release of test planning documentation (i.e., the SPVP). The Contractor shall recommend waivers or deviations to the NPOESS GIID as appropriate and participate in discussions to resolve these waivers.

5.3.3 SYSTEM PERFORMANCE TESTING

The Contractor shall provide all personnel, equipment, and facilities necessary to test the OLI and verify compliance with the OLI Specification, the MAR, and all spacecraft interfaces. The Contractor shall perform the OLI test program in accordance with the SPVP, the OLI STR and MAR and shall calibrate the OLI in accordance with the STR and the Contractor-developed Calibration and Validation Plan. The Contractor shall develop and provide the Calibration and Validation Plan in accordance with the CDRL. The Contractor shall implement the Calibration and Validation Plan. The Contractor shall provide spectral filter witness samples to the Government by arrangement with the COTR. The Contractor shall develop and provide Detailed Test Procedures in accordance with the CDRL. The Contractor shall provide Calibration and Validation Procedures in accordance with the CDRL. The Contractor shall provide Verification Reports and Calibration and Validation Test Reports in accordance with the CDRL. The Contractor shall provide a Calibration and Validation Summary Report in accordance with the CDRL. The Contractor shall document and investigate anomalies and perform anomaly resolution. Anomaly resolution is the identification, investigation, and resolution of anomalies including the characterization of a problem or deficiency, determination of the probable cause or missing functionality, evaluation against existing specifications and requirements, and recommending prospective corrective actions or enhancements. The Contractor shall store and maintain all output data collected from the instrument during ground testing for anomaly resolution. The Contractor shall deliver an Acceptance Data Package in accordance with the CDRL. The Contractor shall measure the mass and center of gravity of the RBS and DSAP prior to shipment.

5.3.4 INDEPENDENT TESTING

To maintain continuity of the Landsat data archives and calibration to the National Institute of Standards and Technology (NIST), the Contractor shall provide access to the Contractor's radiometric calibration sources sufficient for the Government and/or its subcontractors to conduct source characterization at the Contractor's facility. The Contractor shall also provide coordination and support sufficient for the Government and/or its subcontractors to conduct independent pre-launch measurements of the Contractor's radiometric calibration sources at the Contractor's facility.

For Government Transfer Radiometer testing, the Contractor shall provide access sufficient for the Government and/or its subcontractors to conduct source characterization in the Contractor's laboratory environment for a total of five 2-day periods; three 2-day periods prior to RBS calibration; and two 2-day periods after RBS calibration. In addition, the Contractor shall provide access sufficient for the Government and/or its subcontractors to conduct source monitoring during OLI calibration activities.

For NIST/Earth Observing System (EOS) radiometric scale realization activities, two 4-day periods, one prior to RBS calibration with the calibration source and one after, shall be accommodated. The radiometric scale realization activities will involve viewing of the radiometric calibration source(s), typically large aperture integrating spheres, used by the Contractor to calibrate OLI. These sources will be viewed by a number of transfer radiometers and the results will be compared to the Contractor's calibration of this source. The Contractor shall supply access to and an operator for the radiometric calibration source as well as the current radiometric calibration of this source.

The Contractor shall account for these Independent Testing periods of access in the contract and program schedule. The advance notice for arranging such access shall be agreed to by the parties.

5.4 SOFTWARE

The Contractor shall provide all software, including software required for spacecraft-level testing, in accordance with the requirements of the OLI Specification and the MAR.

5.4.1 FLIGHT SOFTWARE

The Contractor shall provide all personnel, hardware, and facilities to develop all flight software.

The Contractor shall provide a Software Design Document in accordance with the CDRL. The Contractor shall develop all OLI software with ANSI/ISO standard languages and a widely-accepted, industry-standard, formal software design methodology (e.g., structured methods, object-oriented design, object modeling technique, Booch method, Software Clean room, etc.). Minimal use of processor-specific assembly language is permitted for certain low-level programs such as interrupt service routines and device drivers with Government approval.

The Contractor shall submit software releases, including delivery of source code and executable code, in a Software Delivery Package in accordance with the CDRL.

The Contractor shall provide a Software Development and Management Plan, a Flight Software Test Plan, Software Test Procedures, Software Test Reports, and a Software Delivery Package in accordance with the CDRL. The Contractor shall develop and provide the OLI Data Format Control Document in accordance with the CDRL. The Contractor shall conduct Verification and Validation activities and support NASA flight software Independent Validation and Verification (IV&V) activities as required by the MAR.

5.4.2 COMMANDS AND TELEMETRY

The Contractor shall provide an OLI Command and Telemetry List and Description document in accordance with the CDRL containing descriptions and lists of all commands and command sequences necessary for successful operation of the OLI.

5.4.3 SOFTWARE MAINTENANCE

The Contractor shall maintain OLI flight software throughout the life of the mission. The Contractor shall maintain flight software development tools and procedures in order to provide uninterrupted support for the life of the mission.

5.4.4 SOFTWARE REVIEWS

The Contractor shall prepare and conduct a Software Preliminary Design Review and a Software Critical Design Review as part of the IPDR and ICDR, respectively. The Contractor shall prepare and conduct a Software Test Readiness Review and a Software Acceptance Review in accordance with the CDRL. The Contractor shall prepare and conduct a GSE Software Test Readiness Review in accordance with the CDRL.

5.4.5 GSE SOFTWARE

The Contractor shall design and provide all software necessary to operate the GSE. The Contractor shall prepare and conduct a GSE software design review as part of the GSE Design Review and provide a review package in accordance with the CDRL.

5.5 STORAGE

The Contractor shall store the instruments at the Contractor facility, if required. The Contractor shall develop and provide Storage Testing Procedures in accordance with the CDRL. The Contractor shall periodically test the instruments while in storage in accordance with the Storage Testing Procedures.

6.0   SPACECRAFT INTEGRATION AND TEST

The Contractor shall provide all personnel, equipment, services, and materials necessary to test the OLI at the spacecraft level of assembly, and to support spacecraft integration and testing. When appropriate, this support shall be provided on-site at the spacecraft contractor's facilities.

6.1   DELIVERY

The Contractor shall provide the personnel, facilities, and hardware necessary to prepare and pack the OLI and its GSE for shipment, and shall be responsible for the transportation and shipment of the material to the designated spacecraft facility. The Contractor shall develop a Packaging, Handling, Storage, and Transportation (PHS&T) Plan and Procedures in accordance with the CDRL and shall deliver the OLI and GSE in accordance with the Plan. The Contractor shall perform a complete post shipment checkout of the instrument and all GSE.

6.2   INTERFACE TESTING

The Contractor shall provide all personnel and equipment necessary to plan, conduct, and verify readiness to interface the OLI with the spacecraft. The Contractor shall provide on-site personnel as required. The Contractor shall provide mounting templates to the spacecraft provider.

6.3   SPACECRAFT INTEGRATION

The Contractor shall plan, conduct, and provide on-site personnel necessary to integrate the OLI to the spacecraft. The Contractor shall perform the following, at a minimum:

      a, Perform safe-to-mate and signal characterization tests on all instruments and GSE prior to electrical mating.
      b. Support OLI-related integration activities and testing conducted by the spacecraft contractor, including alignment and thermal blanket close-outs.
      c. Provide the OLI to Spacecraft Integration Procedure(s) in accordance with the CDRL.

6.4   SPACECRAFT TESTING
The Contractor shall plan, conduct, and provide on-site personnel necessary to support the spacecraft contractor on a 24/7 basis during spacecraft thermal vacuum testing and at other times as required. The Contractor shall perform the following, at a minimum:

      a. Provide on-site support of all performance testing, including real-time monitoring and off-line data analysis, of the instrument after integration on the spacecraft, covering all shifts worked by the spacecraft contractor.
      b. Support OLI-related ambient and environmental testing conducted by the spacecraft contractor.
      c. Support and conduct anomaly investigations involving the OLI and implement corrective actions.

d. Assist in writing procedures for end-to-end compatibility tests.

6.5   PERFORMANCE TESTING

The Contractor shall provide all personnel and equipment necessary to plan, analyze, and verify OLI performance at spacecraft ambient and environmental conditions in accordance with the STR and the MAR. The Contractor shall provide on-site personnel on a 24/7 basis during spacecraft thermal vacuum testing and at other times as required. The Contractor shall provide on-site data analysis for all environmental testing on a 24/7 basis, or whenever the spacecraft contractor is working.

6.6   SHIPMENT

The Contractor shall plan and support all OLI-related activities necessary to safely ship the integrated OLI to the launch base.

7.0   PRE- AND POST-LAUNCH SUPPORT

7.1   PRE-LAUNCH

7.1.1   LAUNCH SITE SUPPORT

The Contractor shall be responsible for OLI functional testing and verification in accordance with the STR during the launch site test phase. The Contractor shall provide on-site personnel as required. The Contractor shall, at a minimum:

   a. Support OLI-related testing conducted by spacecraft contractor.
   b. Execute launch site OLI tests and inspections in accordance with STR
   c. Support and conduct anomaly investigations involving the OLI.
   d. Supply and maintain equipment necessary to conduct OLI testing at launch site. The equipment provided by the Contractor shall include test execution, data analysis, and archive equipment.
   e. Supply software, test procedures, and any other documentation necessary to conduct OLI testing at launch site
   f. Supply personnel to conduct OLI testing at launch site on a 24/7 basis as required.
   g. Support OLI to ground system compatibility testing
   h. Provide console support during launch to monitor instrument health and safety
   i. Provide go/no-go recommendations for launch.

7.1.2   OPERATIONS TRAINING

The Contractor shall train operations personnel in OLI operations. The Contractor shall assume one 3-day training class conducted by two people at the operations facility. The Contractor shall develop and provide Operations and Maintenance Manuals in accordance with the CDRL.

7.2   POST-LAUNCH

The Contractor shall provide post-launch verification and checkout, including provision of on-site personnel at the Mission Operations Control Center. The Contractor shall, at a minimum:

   a. Provide OLI On Orbit Initialization and Validation Plan (OIVP) in accordance with the CDRL.
   b. Provide support on a 24/7 basis during On-Orbit Initialization and Validation (OIV) during instrument check out.
   c. Provide support after instrument check-out as needed.
   d. Review OLI post-launch test data.
   e. Provide the OLI Orbital Procedures in accordance with the CDRL.
   f. Conduct post-launch pre-IOC validations in accordance with the STR.
   g. Support post-IOC Calibration and Validation activities.
   h. Investigate on-orbit anomalies that affect OLI specification-related
   performance parameters and/or anomalies that threaten OLI or spacecraft health and

safety.
i. Provide the On Orbit Performance Report in accordance with the CDRL.

7.3   FLIGHT OPERATIONS

The Contractor shall support post-IOC operations as required. The Contractor shall investigate on-orbit anomalies that affect OLI specification-related performance parameters and/or anomalies that threaten OLI or spacecraft health and safety.

7.4   SUSTAINING ENGINEERING

The Contractor shall maintain the RBS EM and DSAP EM. The Contractor shall maintain the capability to perform analyses, review ground test data flight data, and documentation, operate GSE, and generally support OLI-related investigations for the duration of the contract period.

8.0   FLIGHT MODEL 2 (FM-2)

The Contractor shall develop and deliver a second OLI Flight Model designated as FM-2. For FM-2, the Contractor shall perform all tasks required for FM-1 as set forth in this SOW, except that all testing shall be conducted at acceptance levels and durations, in accordance with the MAR.

9.0   GROUND SUPPORT EQUIPMENT

9.1   CALIBRATION TEST EQUIPMENT

The Contractor shall define, design, build, provide, maintain, document, and ship (as required) all equipment necessary to radiometrically and geometrically calibrate the RBS. The Contractor shall perform tests necessary to demonstrate that all GSE is functioning properly and within specification. The Contractor shall ship an appropriate set of this calibration equipment with the OLI as required to support ambient and thermal vacuum tests at the spacecraft contractor's facility.

9.2   MECHANICAL GSE

The Contractor shall define, design, build, provide, maintain, document, and ship as necessary the OLI mechanical Ground Support Equipment (GSE) throughout the duration of the contract. The mechanical GSE consists of equipment and fixtures required to operate, test, handle, lift, and maintain the OLI and to perform OLI-to-spacecraft integration. Mechanical GSE also includes equipment required to provide the appropriate thermal and vibration test environments as specified in the MAR. The Contractor shall ship all mechanical GSE with the OLI as required to support tests and spacecraft integration at the spacecraft contractor's facility

9.3   ELECTRICAL GSE

The Contractor shall define, design, provide, maintain, document, and ship as necessary OLI electrical GSE throughout the duration of the contract. The electrical GSE consists of the System Test Equipment and software necessary to command, monitor, and test the OLI and the interface cables from the STE to the OLI. The Contractor shall ship all electrical GSE with the OLI as required to support tests and spacecraft integration at the spacecraft contractor's facility. The Contractor shall ensure that any necessary OLI-specific GSE can be operated concurrent with the instrument integration to the spacecraft bus. The Contractor shall provide the spacecraft electrical cables and harnesses, for use in testing, in accordance with the OLI-to-spacecraft ICD.

9.4   SHIPPING, STORAGE, AND PURGE EQUIPMENT

The Contractor shall provide environmentally controlled shipping/storage containers and necessary ancillary equipment for shipment of the STM and the OLI FMs.

The Contractor shall pack and ship all test and support equipment to the spacecraft integration facility and to the launch site, as required.

The Contractor shall pack and ship all test and support equipment back to the Contractor's facility.

The Contractor shall develop and provide all equipment and materials necessary to purge the OLI during instrument, spacecraft, and launch processing activities.

The Contractor shall determine the required quantity of shipping containers.

The Contractor shall be prepared to store the OLI in an environmentally controlled facility for up to a period of two years.

10.0   PERFORMANCE ASSURANCE

The Contractor shall develop, implement, and maintain a comprehensive mission assurance program which meets the requirements of the MAR.

10.1   NONCONFORMANCE REPORTING AND CORRECTIVE ACTION

The Contractor shall have a system for identifying, reporting, controlling, and correcting nonconforming hardware and software in accordance with the MAR. The Contractor shall implement a system for documenting and tracking the disposition of all failures in accordance with the MAR and for reporting these failures in Failure/Anomaly Reports in accordance with the CDRL.

10.2   SYSTEM SAFETY

The Contractor shall implement a system safety program in accordance with the MAR and provide a System Safety Program Plan in accordance with the CDRL. The Contractor shall provide Safety Waiver/Non-Compliance Requests in accordance with the CDRL. The Contractor shall submit all Detailed Test Procedures to be used at GSFC facilities, other integration facilities, or the launch site in accordance with the CDRL. The Contractor shall provide Missile System Pre-Launch Safety Package (MSPSP) Inputs in accordance with the CDRL. This input will be used by the Government to generate the MSPSP for submittal to the launch range.

10.3   RELIABILITY

The Contractor shall plan and implement a reliability program in accordance with the MAR.

10.3.1 RELIABILITY ANALYSES
The Contractor shall perform and deliver a Reliability Report in accordance with the CDRL. The Contractor shall document a Critical Items List in accordance with the CDRL. The Contractor shall perform parts stress analyses and implement a software reliability program in accordance with the MAR. The Contractor shall perform and deliver Worst Case Analyses in accordance with the CDRL.

10.3.2 RELIABILITY ANALYSES OF TEST DATA

The Contractor shall trend selected parameters of test data that relate to performance stability and generate trend analyses reports in accordance with the MAR. The Contractor shall merge the systems engineering trend analysis effort with the reliability trend analysis effort into one trending program. The Contractor shall submit to the Government for approval the list of parameters to be trended in accordance with the CDRL. After implementation, tracking and trend analyses reports shall be provided in accordance with the CDRL.

10.4 PARTS

The Contractor shall plan and implement an Electrical, Electronic, and Electromechanical (EEE) parts control program in accordance with the MAR. The Contractor shall have a Parts Control Plan in accordance with the MAR and make it available for review by the Government. The Contractor shall generate and provide a Parts Identification List in accordance with the CDRL.

10.5 GIDEP ALERTS AND PROBLEM ADVISORIES

The Contractor shall participate in the Government/Industry Data Exchange Program (GIDEP) in accordance with the MAR. The Contractor shall provide Responses to Alerts in accordance with the CDRL.

10.6   MATERIALS, PROCESSES AND LUBRICATION

OLI flight material shall meet the requirements of the MAR. The Contractor shall plan and implement a Materials and Processes Control Program in accordance with the MAR. The Contractor shall provide Material Review Board (MRB) Decisions on Non-Conformance in accordance with the CDRL. The Contractor shall provide and maintain Material Identification Lists in accordance with the CDRL. The Contractor shall develop a Mechanism Life Test Plan in accordance with the CDRL. The Contractor shall qualify all lubricated mechanisms by life testing in accordance with the MAR. The Contractor shall provide and maintain a Limited Life Items List in accordance with the CDRL.

10.7   WORKMANSHIP STANDARDS

The Contractor shall plan and implement an Electronics Packaging and Processes Program in accordance with the MAR. The Contractor shall provide Printed Wiring Board Coupons to the Government by arrangement with the COTR.

10.8   CONTAMINATION CONTROL

The Contractor shall develop and deliver a Contamination Control Plan in accordance with the CDRL. The Contractor shall measure and maintain the levels of cleanliness required during each phase of the hardware's lifetime as established by the Contamination Control Plan. The Contractor shall deliver to the Government for analysis any contamination witness samples in accordance with the requirements of the Contamination Control Plan and by arrangement with the COTR.

10.9   PHOTO DOCUMENTATION

The contractor shall provide Photographic and Video Records in accordance with the CDRL.

11.0 SPARES

The Contractor shall define and implement the spares program necessary to minimize schedule impact for the project created by failures, contamination, or by other plausible events or conditions. In defining the spares program, the Contractor shall consider the reliability, handling, and environment of subsystems, components, and parts, hence the likelihood that these items would need to be replaced. The Contractor shall provide a Spare Parts List in accordance with the CDRL. The Contractor shall qualify, test, and calibrate the spares as appropriate.

12.0   OPTIONAL INSTRUMENT (FM-3)

Upon exercise of Option 1 of the Contract by the Government, the Contractor shall develop and deliver a third OLI Flight Model designated as FM-3. For FM-3, the Contractor shall perform all tasks required for FM-2 as set forth in this SOW, except that all testing shall be conducted at acceptance levels and durations, in accordance with MAR.